SUGGESTED REMARKS: AERO CLUB OF WASHINGTON

APRIL 24, 1984, WASHINGTON, D.C.

NASA ADMINISTRATOR JAMES M. BEGGS

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THANK YOU AL (GLESKE), AND THANK YOU LADIES AND GENTLEMEN FOR YOUR WARM WELCOME. I AM DELIGHTED TO SEE YOU ALL AGAIN.

WHEN I LAST SPOKE BEFORE THIS GROUP IN JANUARY 1982 THE AEROSPACE INDUSTRY WAS ABOUT TO BEGIN A YEAR OF DECLINE REFLECTING THE RECESSIONARY ECONOMY. AT YEAR'S END, CIVIL AIRCRAFT SALES HAD DROPPED, AEROSPACE EXPORTS WERE DOWN, AS WERE EMPLOYMENT AND PROFITS. AND COMPETITION FROM ABROAD WAS UP.

NEVERTHELESS, MY MESSAGE TO YOU AT THE BEGINNING OF THAT YEAR WAS AN EXERCISE IN POSITIVE THINKING THAT NORMAN VINCENT PEALE WOULD HAVE BEEN PROUD OF. I SAID THEN THAT THE INDUSTRY WAS TOO IMPORTANT TO OUR ECONOMY AND TO OUR ECONOMIC GROWTH FOR IT LIE FALLOW FOR LONG. FORTUNATELY FOR THE NATION, AND, INCIDENTALLY, FOR MY REPUTATION AS AN OPTIMIST, THIS HAS TURNED OUT TO BE THE CASE.

LAST YEAR SALES, PROFITS, AND EMPLOYMENT BEGAN TO TURN UP. AND AS THE ECONOMY CONTINUES TO RECOVER, THERE IS EVERY REASON TO BELIEVE THAT THE INDUSTRY'S GROWTH WILL ACCELERATE.

THIS IS GOOD NEWS FOR ALL OF US BECAUSE THE AEROSPACE INDUSTRY EMPLOYS ALMOST 1.2 MILLION PEOPLE AND ACCOUNTS FOR 2.25 PER CENT OF THE GROSS NATIONAL PRODUCT. AND EVEN WITH A RECORD UNITED STATES TRADE DEFICIT LAST YEAR, THE INDUSTRY RECORDED A POSITIVE TRADE BALANCE OF $12.8 BILLION, THE LARGEST FOR ANY INDUSTRY GROUP.

SO I BELIEVE THE AEROSPACE INDUSTRY IS, INDEED, WELL POSITIONED TO MEET TOMORROW'S CHALLENGES, BOTH AT HOME AND ABROAD.

BOTH SPACE AND AERONAUTICAL TECHNOLOGY OFFER POTENTIAL FOR SIGNIFICANT FUTURE ADVANCES. BUT TODAY I WOULD LIKE TO FOCUS ON AERONAUTICAL RESEARCH AND TECHNOLOGY AND TO TAKE A BRIEF LOOK AT FOUR AREAS WHICH I BELIEVE OFFER SIGNIFICANT NEW CHALLENGES AND OPPORTUNITIES FOR THE 21ST CENTURY. THESE AREAS ARE SUPERSONIC CRUISE TRANSPORTATION, HIGH SPEED ROTORCRAFT, SHORT-HAUL SUBSONIC TRANSPORTATION AND HYPERSONIC FLIGHT.

FIRST, SUPERSONIC CRUISE TECHNOLOGY. THE CONCORDE HAS PROVEN THE TECHNICAL FEASIBLITY, IF NOT THE ECONOMIC VIABILITY, OF SUPERSONIC AIR TRANSPORTATION. BUT OVER THE NEXT CENTURY, I BELIEVE SEVERAL TRENDS WILL COMBINE TO BRIGHTEN THE OUTLOOK FOR AN ADVANCED TECHNOLOGY SUPERSONIC TRANSPORT.

THE MOST IMPORTANT TREND IS A PROJECTED POPULATION GROWTH OF MORE THAN 75 PER CENT IN THE DEVELOPING NATIONS OF THE PACIFIC OCEAN AREA, SOUTH AMERICA, ASIA AND AFRICA. WITH THIS GROWTH WILL COME INCREASED TRADE AND MORE MULTINATIONAL BUSINESS ACTIVITIES IN THOSE AREAS, CREATING A MARKET FOR LONG-RANGE INTERCONTINENTAL TRANSPORTATION AT DISTANCES CONSIDERABLY GREATER THAN THOSE THE CONCORDE FLIES TODAY.

SINCE MOST OF THE TRAVEL WOULD BE BUSINESS, RATHER THAN TOURIST-ORIENTED, THIS WILL INCREASE THE VALUE OF REDUCED TRIP TIME AND INCREASED PRODUCTIVITY.

MAJOR AIRCRAFT MANUFACTURERS HAVE CONDUCTED DESIGN STUDIES THAT INDICATE THAT THAT AN ADVANCED TECHNOLOGY SUPERSONIC TRANSPORT COULD CARRY 300 TO 400 PASSENGERS OVER INTERCONTINENTAL RANGES AT MORE THAN THREE TIMES THE SPEED AND THE PRODUCTIVITY OF TODAY'S SUBSONIC TRANSPORTS. ESTIMATES ON OPERATING COSTS SUGGEST THAT FARES WOULD BE RELATIVELY AFFORDABLE. AND WITH SOME CONFIGURATIONS UNDER STUDY THE SONIC BOOM OVERPRESSURES WOULD BE LOW ENOUGH TO FLY THE AIRCRAFT OVER LAND.

THE SST OF THE FUTURE WOULD INCORPORATE SUCH NEW TECHNOLOGY AS HIGHLY EFFICIENT AERODYNAMIC CONFIGURATIONS, LAMINAR FLOW CONTROL, ADVANCED HIGH-TEMPERATURE STRUCTURAL DESIGN AND VARIABLE CYCLE ENGINES, WHICH WOULD PROVIDE A 40 PER CENT INCREASE IN SUPERSONIC CRUISE EFFICIENCY AND LOW NOISE ON TAKEOFF.

RECENT STUDIES HAVE INDICATED THAT SUPERSONIC CRUISE TECHNOLOGY WOULD ALSO HAVE IMPORTANT APPLICATIONS FOR COMBAT AIRCRAFT. COUPLED WITH HIGH MANEUVERABILITY, SUSTAINED SUPERSONIC CRUISE WOULD RESULT IN GREATER COMBAT EFFECTIVENESS AND SURVIVABILITY. AND THE HIGHER THRUST-TO-WEIGHT RATIOS OF THIS TECHNOLOGY SUGGEST THE FEASIBILITY OF SHORT TAKEOFF AND VERTICAL LANDING, OR STOVL, CAPABILITY FOR FUTURE FIGHTERS.

DURING THE NEXT CENTURY WE WILL ALMOST CERTAINLY SEE ADVANCES IN HIGH-SPEED ROTORCRAFT TECHNOLOGY AS WELL. THEY WILL STEM FROM CONTINUED PROGRESS IN AERO-STRUCTURAL DYNAMICS, REDUCTION OF NOISE AND VIBRATION, ALL-WEATHER GUIDANCE AND NAVIGATION, ADVANCED CONTROLS AND CONTROL INTEGRATION AND ADVANCED STRUCTURES.

FUTURE ROTORCRAFT MAY ALSO BENEFIT FROM ADVANCES IN SMALL TURBINE ENGINES. RECENT RESEARCH HAS SHOWN THAT NEW HIGH-TEMPERATURE MATERIALS AND ADVANCED COMPONENT TECHNOLOGY CAN BE DEVELOPED TO PERMIT MAJOR IMPROVEMENTS IN FUEL CONSUMPTION AND THRUST-TO-WEIGHT RATIOS OF SMALL ENGINES. THESE ADVANCES COULD HAVE APPLICATIONS NOT ONLY IN ROTORCRAFT, BUT IN GENERAL AVIATION AND IN CRUISE MISSILES AS WELL.

TILT-ROTOR TECHNOLOGY DEVELOPED IN A JOINT NASA/ARMY RESEARCH AND DEVELOPMENT PROGRAM IS NOW BEING CONSIDERED FOR APPLICATION IN THE NAVY'S JVX PROGRAM. THIS TECHNOLOGY MAKES IT POSSIBLE FOR A VEHICLE TO FLY VERTICALLY AND HOVER LIKE A HELICOPTER, AND TO ALSO FLY FORWARD SMOOTHLY AND QUIETLY AT SPEEDS APPROACHING THOSE OF PROPELLER-DRIVEN AIRPLANES. THESE COMBINED CAPABILITIES REPRESENT A FIRST, BUT IMPORTANT STEP TOWARD ENTIRELY NEW GENERATIONS OF HIGH-SPEED ROTARY-WING AIRCRAFT WHICH COULD SERVE A VARIETY OF CIVIL AND MILITARY NEEDS IN THE NEXT CENTURY.

SHORT-HAUL SUBSONIC TRANSPORTATION IS A THE THIRD AREA OF CHALLENGE AND OPPORTUNITY FOR THE NEXT CENTURY.

THE NEED FOR EFFICENT, SHORT-HAUL AIR TRANSPORTATION WILL INCREASE RAPIDLY, BOTH IN THE UNITED STATES AND ABROAD, AS POPULATION CONTINUES TO GROW AND SHIFT FROM OLDER METROPOLITAN AREAS TO NEW URBAN AREAS AND INDUSTRIAL CENTERS. TODAY'S LOW-COST, SMALL COMMUTER AIRCRAFT WILL ALMOST CERTAINLY GIVE WAY TO LARGER AIRCRAFT SEATING 50 TO 100 PASSENGERS OR MORE. THESE NEW AIRCRAFT WILL BE DESIGNED TO LARGE-TRANSPORT STANDARDS OF AIRWORTHINESS, OPERATION, SAFETY AND DEPENDABILITY. THEY WILL ALSO BE DESIGNED FOR MAXIMUM EFFICIENCY DURING CLIMB, DESCENT AND SHORT-STAGE-LENGTH FLIGHTS. AND THEY WILL BE ABLE TO OPERATE SAFELY AND QUIETLY AT RELATIVELY SMALL AIRPORTS OR ON SHORT RUNWAYS AT HUB TERMINALS.

ADVANCED TUROPROP TECHNOLOGY WOULD ESPECIALLY BENEFIT THIS NEW GENERATION OF SHORT-HAUL TRANSPORTS BECAUSE IT WOULD PROVIDE GREATER FUEL ECONOMY FOR THE SHORTER DISTANCES. OTHER ADVANCES IN SUCH KEY AREAS AS DRAG REDUCTION, LIGHTWEIGHT STRUCTURES, ACTIVE CONTROLS TECHNOLOGY AND SAFETY ALSO WOULD PROBABLY BE INCORPORATED.

THE LAST AREA I EXPECT TO BE DEVELOPED IN THE NEXT CENTURY IS HYPERSONIC FLIGHT. THAT, AS YOU KNOW, IS THE SPEED EQUAL TO OR EXCEEDING FIVE TIMES THE SPEED OF SOUND, OR MORE THAN 3800 MILES AN HOUR.

IN THE EARLY 1960S THE X-15 RESEARCH AIRPLANE PERMITTED SOME EXPLORATION OF THE HYPERSONIC REGIME AND, INDEED, HELPED SET THE STAGE FOR THE SPACE SHUTTLE, WHICH MUST FLY AT HYPERSONIC SPEEDS IN THE ATMOSPHERE FOR RELATIVELY SHORT PERIODS TO AND FROM ORBIT.

BECAUSE OF PROBLEMS IN PROPULSION AND AERODYNAMIC HEATING, IT IS DIFFICULT TO SUSTAIN HYPERSONIC FLIGHT IN THE ATMOSPHERE FOR MUCH LONGER PERIODS.

BUT, AS SHAKESPEARE ONCE WROTE, "ALL DIFFICULTIES ARE BUT EASY WHEN THEY ARE KNOWN." OUR RESEARCH IS INDICATING THAT THESE PROBLEMS CAN BE SOLVED, AND I BELIEVE THAT HYPERSONIC FLIGHT OPERATIONS IN THE NEXT CENTURY COULD BE MADE PRACTICAL AND, PERHAPS, EVEN ROUTINE.

THE FIRST GENERATION OF HYPERSONIC OPERATIONAL VEHICLES COULD BE LONG-RANGE CRUISE MISSILES USING SUPERSONIC-COMBUSTION RAMJETS (WE CALL THEM SCRAMJETS) AND HIGH-DENSITY HYDROCARBON FUELS. THESE VEHICLES WOULD BE FOLLOWED BY CRUISE AIRPLANES FLYING AT MACH 5 TO MACH 7 AT VERY HIGH ALTITUDES FOR STRATEGIC RECONNAISSANCE.

THERE IS ALSO RENEWED INTEREST IN A HYPERSONIC MANEUVERING AIRPLANE CAPABLE OF SUSTAINED OPERATION IN BOTH THE ATMOSPHERE AND IN LOW EARTH ORBIT. SUCH A CRAFT WOULD USE A COMBINATION OF SCRAMJET AND ROCKET PROPULSION TO MATCH THE TRANSATMOSPHERIC ENVELOPE. AND IT WOULD PROBABLY BE ABLE TO TAKE OFF AND LAND HORIZONTALLY.

NASA HAS BEEN DOING SCRAMJET PROPULSION RESEARCH FOR MANY YEARS. AND WE HAVE MADE ENCOURAGING PROGRESS. BUT THE DIFFICULTY HAS BEEN THAT IF THE SCRAMJET IS TO PROVIDE EFFICIENT HYPERSONIC PROPULSION, IT CANNOT BE VIEWED AS AN ENGINE ISOLATED FROM THE CRAFT IT IS PROPELLING. RATHER, THE HIGH-TEMPERATURE STRUCTURE OF THE VEHICLE ITSELF MUST BE USED AS THE ENGINE INLET. AND PORTIONS OF THE STRUCTURE MUST BE MOVED BY AN AUTOMATED CONTROL SYSTEM TO PROVIDE THE NECESSARY INLET AND NOZZLE ADJUSTMENTS. CLEARLY, IF WE ARE TO USE THIS TECHNOLOGY EFFECTIVELY, WE WILL NEED A HIGHLY COORDINATED SYSTEMS-RESEARCH EFFORT IN THE FOUR KEY AREAS OF PROPULSION, AERODYNAMICS, STRUCTURES AND CONTROLS.

AS HAS BEEN TRUE IN THE PAST, THE EFFICIENCY AND EFFECTIVENESS OF FUTURE AIRCRAFT WILL DEPEND ON HOW WELL WE INTEGRATE TECHNOLOGY IN THOSE FOUR AREAS. THE UNIQUE TECHNOLOGY INGETRATION REQUIREMENTS OF THE FLIGHT ENVIRONMENT DEMAND A FULL SPECTRUM OF GROUND-BASED FACILITIES AND FLIGHT RESEARCH TEST BEDS. MANY ALREADY EXIST AT NASA FACILITIES AND WE ARE DEVELOPING OTHERS. THE NEW NUMERICAL AERODYNAMIC SIMULATION PROGRAM, FOR EXAMPLE, WILL PROVIDE THE UNITED STATES WITH THE WORLD'S MOST ADVANCED COMPUTATIONAL CAPABILITY AND ALSO WILL ALLOW US TO USE FUTURE ADVANCES IN HIGH-SPEED NUMERICAL PROCESSORS TO OUR ADVANTAGE.

EVENTUALLY WE MAY REQUIRE NEW EXPERIMENTAL AIRCRAFT AS WELL. THE TILT-ROTOR XV-15 AND THE PROPULSIVE-LIFT QUIET SHORT-HAUL RESEARCH AIRCRAFT ARE CURRENT EXAMPLES OF NASA EXPERIMENTAL AIRCRAFT AND THEY HAVE BEEN VERY SUCCESSFUL. SIMILAR ACTIVITY IS UNDERWAY WITH DARPA'S X-29 FORWARD-SWEPT WING AND X-WING RESEARCH AIRCRAFT. SOME OF THESE PROGRAMS HAVE BEEN FUNDED SOLELY BY NASA, SOME FUNDED SOLELY BY THE DOD AND SOME JOINTLY BY BOTH AGENCIES. I BELIEVE THIS APPROACH SHOULD BE CONTINUED INTO THE FUTURE, WITH SPONSORSHIP OF EACH PROGRAM TO BE BASED ON ITS CONTENT AND FUTURE MAJOR APPLICATIONS. FOR EXAMPLE, FUTURE RESEARCH VEHICLES IN THE HYPERSONIC AND SUPERSONIC STOVL AREAS SHOULD BE FUNDED PRINCIPALLY BY THE DOD, SINCE MILITARY APPLICATIONS WILL BE THE PRIMARY DRIVER FOR THE FORESEEABLE FUTURE.

LOOKING TO THE FUTURE, I BELIEVE THE NEXT CENTURY WILL BE AN ERA OF GROWTH AND ADVANCES IN AERONAUTICAL TECHNOLOGY THAT WILL SURPASS EVEN OUR ACHIEVEMENTS SINCE THE BIRTH OF POWERED FLIGHT MORE THAN 80 YEARS AGO.

IN THE SPAN OF A HUMAN LIFETIME THE UNITED STATES HAS SOARED FROM THE SANDS OF KITTY HAWK TO THE ROUTINE ACCESS TO SPACE WE ENJOY TODAY WITH THE SPACE SHUTTLE. WE HAVE DEVELOPED AN UNRIVALED PUBLIC AIR TRANSPORTATION SYSTEM AND A FLEET OF PRIVATE AIRCRAFT PROVIDING PERSONAL AIR TRANSPORTATION THAT HAS NO EQUAL IN THE WORLD. AND WE HAVE MAINTAINED A CLEAR PREEMINENCE IN MILITARY AIR CAPABILITY.

ALVIN TOFFLER, THE AUTHOR OF "FUTURE SHOCK", ONCE WROTE THAT WE ARE AWASH ON A TIDAL WAVE OF CHANGE. AND CERTAINLY, NOTHING IS MORE INEVITABLE THAN CHANGE. BUT HISTORY TEACHES US THAT CHANGE, HOWEVER SUDDEN, HAS ITS ROOTS DEEP IN WHAT HAS GONE BEFORE.

OUR ACHIEVEMENTS IN AERONAUTICAL TECHNOLOGY HAVE BUILT A SOLID FOUNDATION FOR FUTURE ACCOMPLISHMENTS THAT WILL REVOLUTIONIZE AIR TRANSPORTATION IN THE NEXT CENTURY. AND NASA IS PROUD TO BE PLAYING A CRUCIAL ROLE IN MEETING THAT EXTRAORDINARY CHALLENGE.

THANK YOU VERY MUCH.